

11. RADIOLOGICAL EFFLUENT RELEASE DOSE CONSEQUENCES FROM NORMAL OPERATIONS

11.1 Source Terms

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the information on radiological dose consequences caused by gaseous and liquid effluents that may be released from normal operation of the plant that was provided by reference in Site Safety Analysis Report (SSAR) Section 2.3.5.1 and included in the Environmental Report Section 5.4 and Tables 3.1-9, 5.4-10, and 5.4-11 of the Dominion Nuclear North Anna, LLC (Dominion or the applicant), early site permit (ESP) application to determine whether site characteristics are such that the radiation dose to members of the public would be within regulatory requirements.

11.1.1 Technical Information in the Application

The applicant provided information on the radiological impacts on members of the public from gaseous and liquid effluents that would be generated as a normal byproduct of nuclear power operations. The applicant described the exposure pathways by which radiation and radioactive effluents can be transmitted to members of the public in the vicinity of the site. The estimates on the maximum doses to the public are based on the available data on the reactor designs being considered using the plant parameter envelope (PPE) approach in which the bounding liquid and gaseous radiological effluents were used in the evaluation. The applicant evaluated the impact of these doses by comparing them to regulatory limits.

Using the PPE approach, Dominion provided a list of fission and activation products that may be released as liquid and gaseous effluents from the postulated new units. The applicant evaluated the impacts from releases and direct radiation by considering the probable pathways to individuals, populations, and biota near the proposed new units. The applicant also calculated the highest dose from the major exposure pathways for a given receptor.

If built, the postulated new units at the North Anna ESP site would release liquid effluents into the waste heat treatment facility (WHTF) through the discharge canals used for the operating units. The applicant considered the following liquid pathways—ingestion of aquatic food; ingestion of drinking water; exposure to shoreline sediment; and exposure to water through boating, swimming, and other activities.

Dominion also considered gaseous pathways, including external exposure to the airborne plume, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products, in its application.

The applicant calculated the dose to the maximally exposed individual (MEI) from both the liquid and gaseous effluent release pathways and calculated a collective whole body dose for the population within 50 miles (mi) of the North Anna ESP site.

11.1.2 Regulatory Evaluation

NRC regulations require that applicants for an ESP address the characteristics of the proposed site that could affect the radiation dose to a member of the public from radiological effluents. In

SSAR Section 1.8.1, the applicant identified the applicable NRC regulations as Title 10, Section 52.17(a)(1)(iv), of the *Code of Federal Regulations* (10 CFR 52.17(a)(1)(iv)). Specifically, this regulation states that an ESP application should describe the anticipated maximum levels of radiological effluents that each facility will produce. Furthermore, 10 CFR 100.21(c)(1) requires that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site be met for any individual located off site. The staff reviewed this portion of the application for conformance with the applicable regulations.

11.1.3 Technical Evaluation

During normal operation, small quantities of radiological materials are expected to be released to the environment through gaseous and liquid effluents from the plant.

11.1.3.1 Gaseous Effluents

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the gaseous effluents using radiological exposure models based on Regulatory Guide (RG) 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," issued March 1976; RG 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," issued October 1977, and the GASPARD II computer program (NUREG/CR-4653, "GASPARD II—Technical Reference and User Guide," March 1987).

Section 2.3.5 of this safety evaluation report discusses the derivation of the atmospheric dispersion parameters used in the applicant's radiological dose assessment.

Dominion calculated the gaseous pathway doses to the MEI using the GASPARD II program at the nearest site boundary, nearest vegetable garden, nearest residence, and nearest meat cow. The applicant did not calculate doses from the milk pathway because no milk cows or goats are located within a 5-mile radius of the ESP site. Table 5.4-7 of the environmental report includes the gaseous effluent releases used to estimate dose to the MEI. These releases, which were estimated for one unit, considered the advanced boiling-water reactor (ABWR) design to have an output level of 4300 megawatt thermal (MWt), rather than the certified level of 3926 MWt. This difference resulted in a slight increase in release rate for those isotopes for which the ABWR design, as certified, was the bounding condition. Tables 5.4-3 through 5.4-5 of the environmental report include other inputs to the GASPARD II program, including meat and vegetable production rates, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors. Table 5.4-9 of the environmental report presents the gaseous pathway doses to the MEI calculated by the applicant. The staff performed an independent evaluation of gaseous pathway doses with similar results.

In Table 1.3-8 of the SSAR, the applicant estimated the radiological dose consequences caused by gaseous effluents that may be released from normal operation of the plant. The applicant determined the gaseous radioactive effluent concentrations based on a composite of the highest activity content of the individual isotopes it anticipated would be released from the alternative reactor designs under consideration.

The applicant also provided a bounding gaseous effluent source term to support its compliance with the gaseous effluent release concentration limits in Table 2 of Appendix B, "Annual Limits on Intakes (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20, "Standards for Protection Against Radiation."

11.1.3.2 Liquid Effluents

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the liquid effluents using radiological exposure models based on RG 1.109 and the LADTAP II computer program (NUREG/CR-4013, "LADTAP II—Technical Reference and User Guide," April 1986).

Dominion calculated liquid pathway doses using the LADTAP II program for various activities, including eating fish and invertebrates caught near the discharge point; drinking water from Lake Anna; and boating, swimming, and using the shoreline for recreational purposes. Table 5.4-6 of the environmental report includes the liquid effluent releases for one new unit used in the estimate of dose to the MEI. These releases considered the ABWR design to have an output level of 4300 MWt, rather than the certified level of 3926 MWt. This difference resulted in a slight increase in release rate for those isotopes for which the ABWR design was the bounding condition. Tables 5.4-1 and 5.4-2 of the environmental report include other parameters used as input to the LADTAP II program, including effluent discharge rate, dilution factor for discharge, transit time to receptor, and impoundment concentration.

The applicant calculated liquid pathway doses to the MEI, including a maximum annual dose to the total body of 0.013 milliSievert (mSv) (1.3 millirem (mrem)) for the adult. Dominion calculated the maximum annual dose to the thyroid as 0.013 mSv (1.3 mrem) for the infant and the maximum annual dose to the liver as 0.017 mSv (1.7 mrem) for the child. The staff performed an independent evaluation of liquid pathway doses with similar results. The staff concludes that the applicant has provided a bounding assessment to demonstrate its capability to comply with the regulatory requirements in 10 CFR Part 20 and Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

11.1.4 Conclusions

The applicant provided adequate information to provide reasonable assurance that it will control, monitor, and maintain radioactive gaseous and liquid effluents from the ESP site within the regulatory limits described in 10 CFR Part 20, as well as maintain them at as low as is reasonably achievable (ALARA) levels, in accordance with the effluent design objectives contained in Appendix I to 10 CFR Part 50.

As set forth above, the staff has independently verified the adequacy of the applicant's dose consequence calculations from normal operations. A combined license (COL) or construction permit (CP) applicant that references an ESP for the North Anna site should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid

effluents for any facility to be built on the North Anna site are bounded by the radiological doses included in the ESP application and reviewed by the NRC staff as described above. This includes any changes made to the input parameters used to calculate the radiological doses (i.e., meteorological data, distance to receptors, and land use data). In addition, detailed information on the solid waste management system used to process the radioactive gaseous and liquid effluents will be required. This is **COL Action Item 11.1-1**.

Based upon these considerations, the staff concludes that radiological doses to members of the public from radioactive gaseous and liquid effluents resulting from the normal operation of one or more new nuclear power plants that might be constructed on the proposed ESP site do not present an undue risk to the health and safety of the public. Therefore, the staff concludes, with respect to radiological effluent release dose consequences from normal operations, that the proposed site is acceptable for constructing a plant falling within the applicant's PPE, and that the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria."